A High Performance MEMS Thin-Film Teflon Electret Microphone

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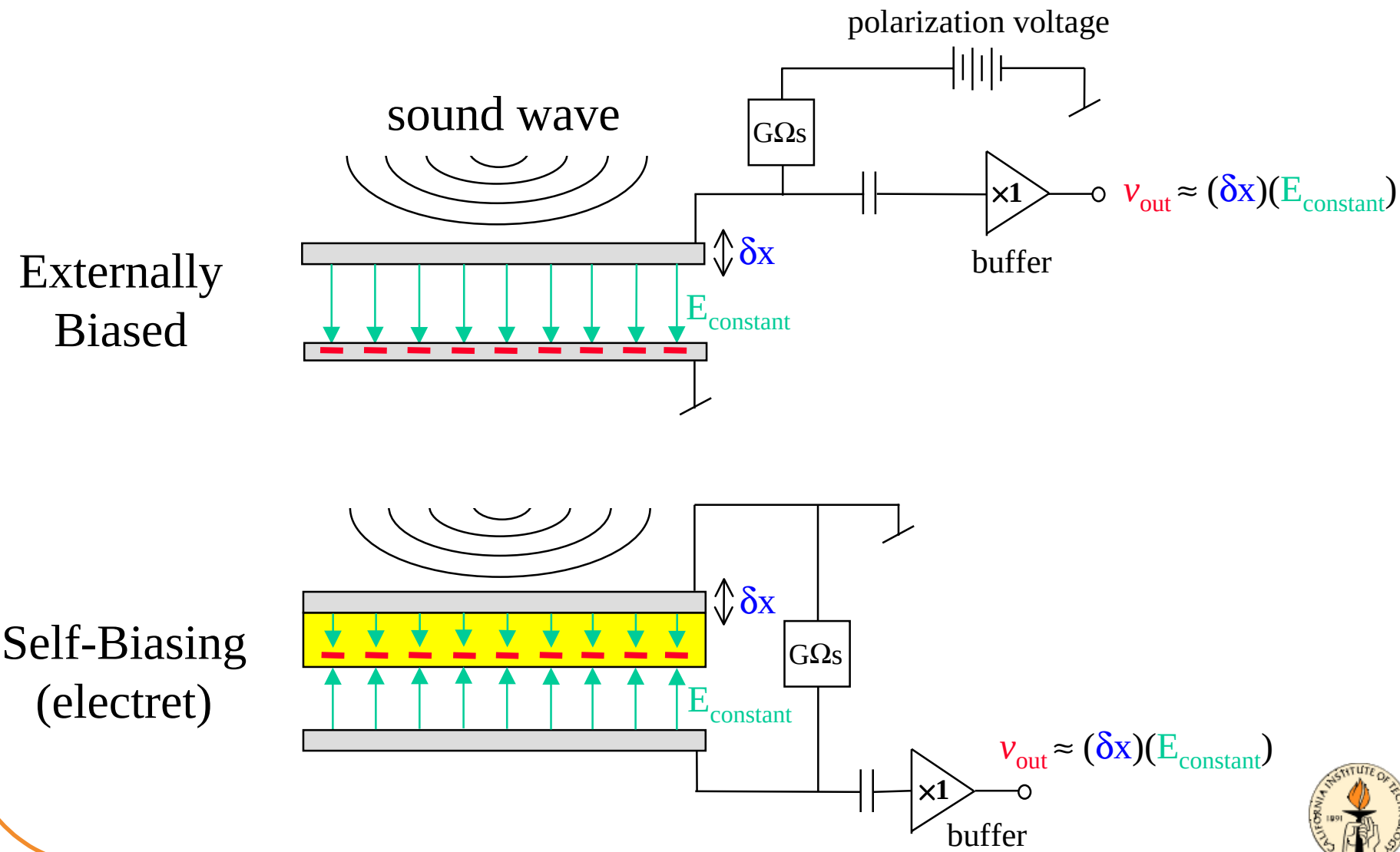
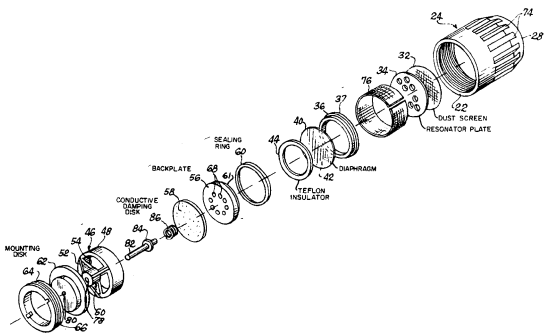
Condenser Microphones: Principal of Operation

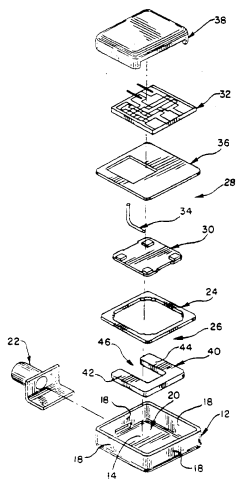


Micromachined Electret Condensor Microphones

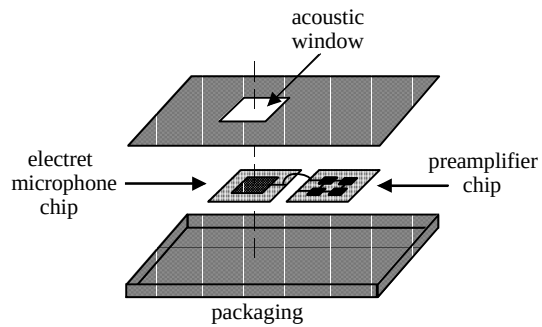
- Requires no external power source (self-biasing)
- Can be *mm*-scale with high sensitivity (10+ mV/Pa)
- Integrable with on-chip electronics
- Mass producible like ICs → low cost, high yield
- Structurally simple → increased reliability



Electro-Voice®



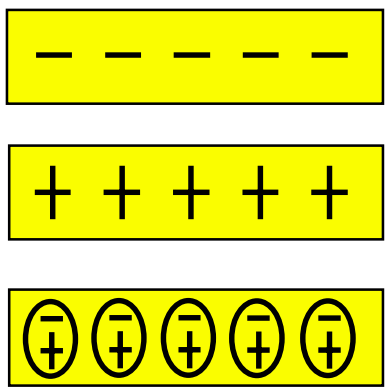
Knowles®



Our Envisioned Micromachined Microphone

What is an Electret?

dielectric with trapped charge



τ_{decay} =
10's - 100's yrs

History

1732	*Electret phenomena (Gray)*	*[slabs]*
1919	*Wax electrets (Eguchi)*	*[mm]*
1950+	*PTFE, PVDF, Mylar sheet [>10 μm]*	
1962	*1st electret mic. by Sessler*	*[6 μm]*
1997	***Thin film Teflon electret***	***[1 μm]***

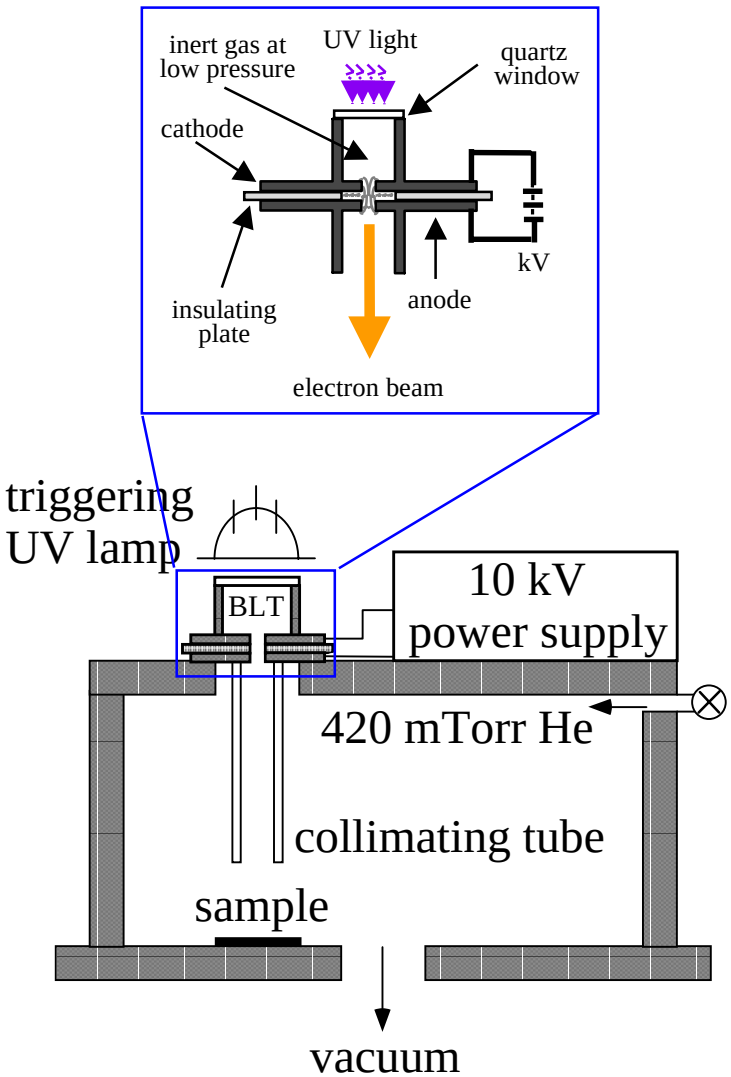
Applications

- *μ*– microphone/speaker
- *μ*– air filters
- *μ*– motors & generators

Thin Film Teflon® Electret Technology

Material	DuPont Teflon® AF
Application	Spin on, bake @ 200°C
Charge Implantation	Back-Lighted Thyratron pulsed electron gun (keV e^-s)
Charge Stabilization	Thermal annealing
Charge Measurement	Charge compensation method
Achievable Stable Charge Densities	1×10^{-5} C/m^2 to 8×10^{-4} C/m^2

Charge Implantation using the BLT



Advantages

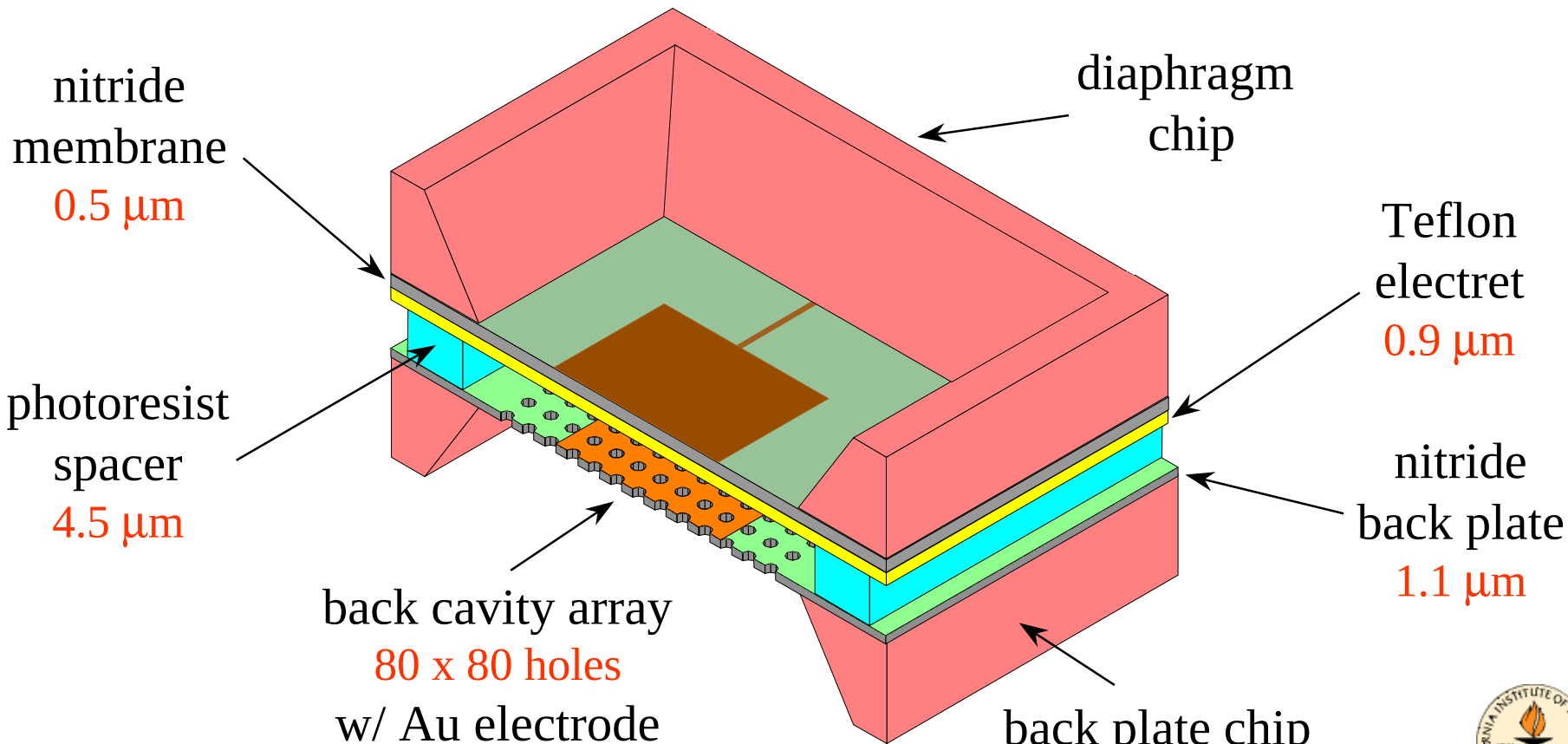
- Room temperature
- Large beam size (>mm)
- Variable energy
  (5 keV - 30 keV)
- High electron dose
  (10^{-9} - 10^{-6} C)
- High throughput
- Low Cost

MEMS Electret Microphone

Sensitivity: ~ 45 mV/Pa

Dynamic Range: less than 30 - 110+ dB SPL

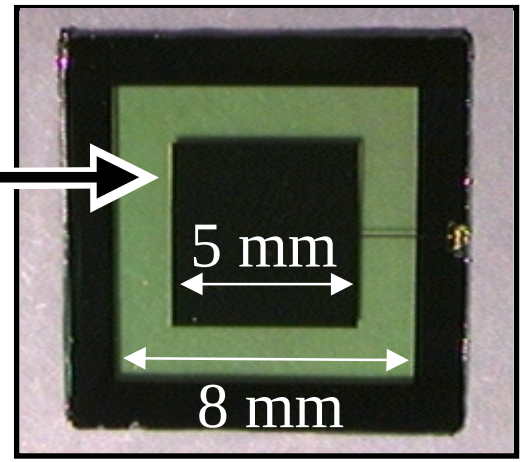
THD: <1% @ 110 dB SPL, 650Hz



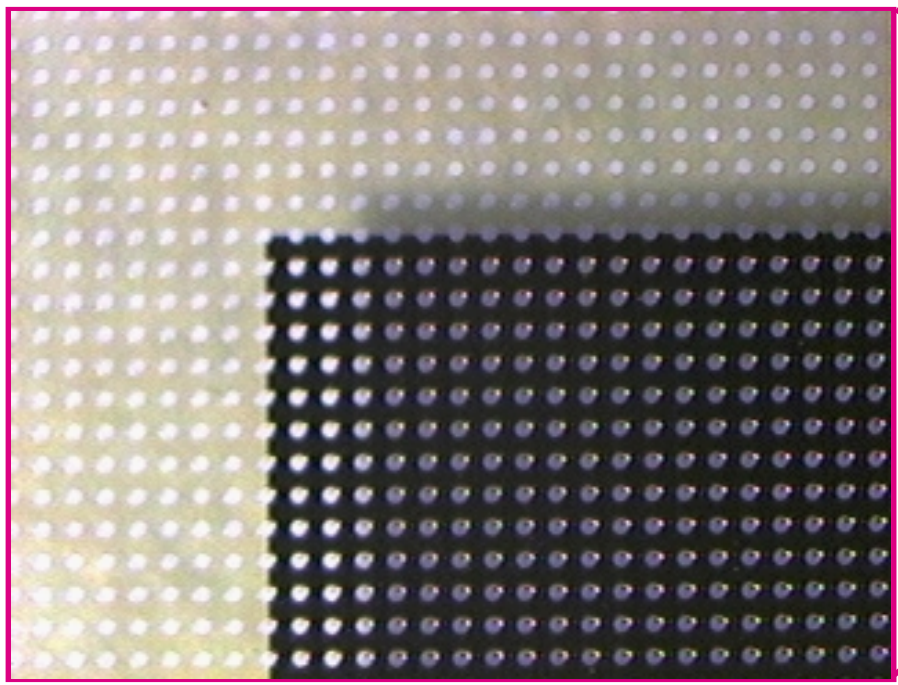
Microphone Diaphragm & Back Plate

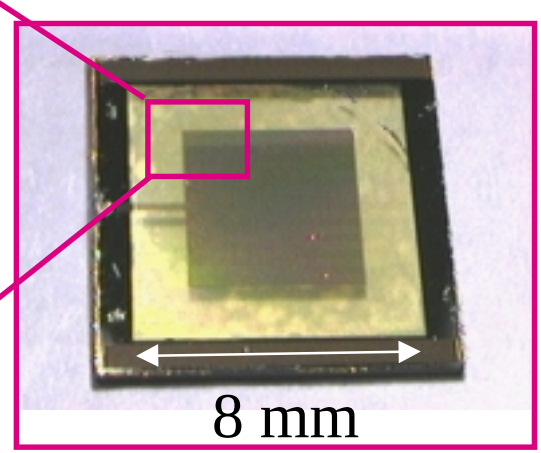
Nitride membrane die

Cr/Au electrode

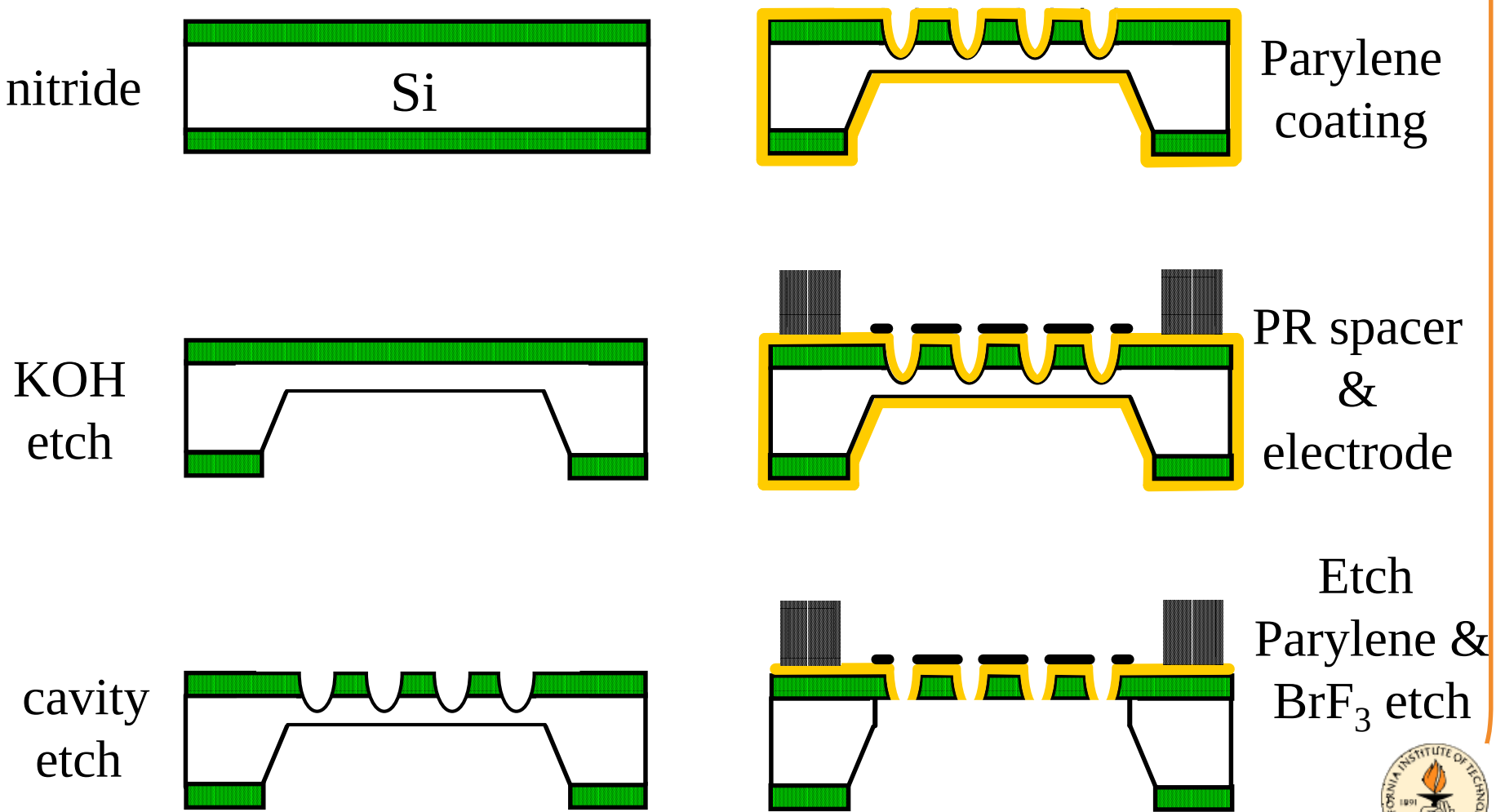


160 x 160 back cavity array

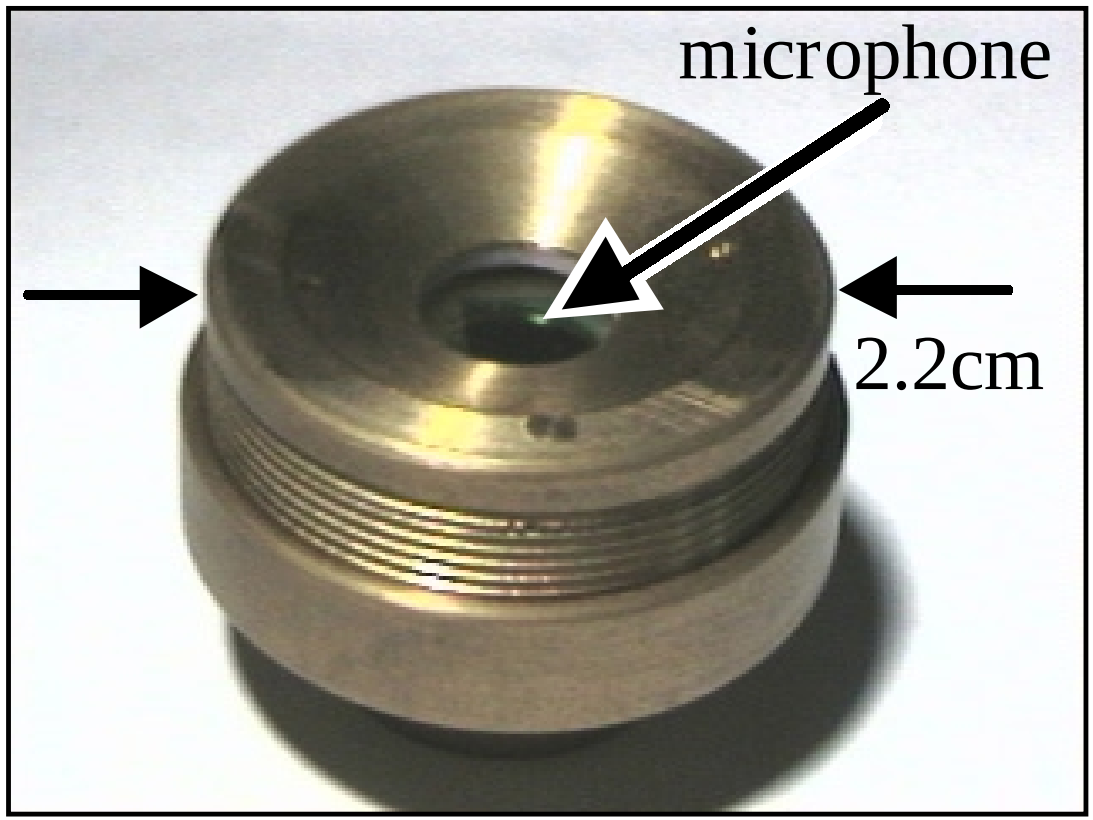




Microphone Back Plate Process Flow



Electret Microphone Package



Microphone Characteristics

Bias Voltage: 0 V

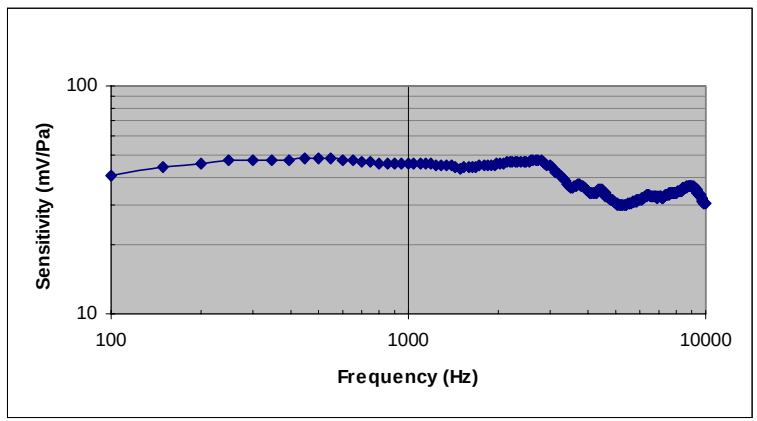
Open-circuit Sensitivity: ~ 45 mV/Pa (150-3000 Hz)

(comparable to B&K 1/2” 4189 electret microphone!)

Frequency Range: 100 Hz - 10 kHz

Dynamic Range: less than 30 - over 110 dB SPL

THD: <1% @ 110 dB SPL, 650Hz



Frequency Response

Microphone Array for Directional Acoustics